ORIGINAL

FNUF
1.4V2
4/15/07

FUDS SIT

ecology and environment, inc.
International Specialists in the Environment

1500 First Interstate Center, 999 Third Avenue
Seattle, Washington 98104
Tel: (206) 624-9537, Fax: (206) 621-9832

April 15, 1997

Mr. Mark Ader
United States Environmental Protection Agency
1200 Sixth Avenue, Mail Stop ECL-115
Seattle, Washington 98101

Re: Contract No. 68-W6-0008
TDD No. 96-11-0007

Dear Mr. Ader:

Enclosed please find a copy of the final Site Inspection (SI) report for the former NIKE Missile Launch Site #81, located near Poulsbo, Washington. The SI included limited sampling at potential contaminant source areas and migration pathways for characterization.

If you have any questions regarding this deliverable, please call me at 206/624-9537.

Sincerely,

ECOLOGY AND ENVIRONMENT, INC.

Jeff Fowlow
Project Leader

Enclosures

cc: Gary Sink, START Project Leader, USEPA, Seattle (Mail Stop ECL-116))
William Carberry, START Program Manager, E & E, Seattle

FINAL
SITE INSPECTION REPORT
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

START REGION X

Contract No. 68-W6-0008
Technical Directory Document No. 96-11-0007

APRIL 1997

Prepared By:

ECOLOGY AND ENVIRONMENT, INC.
1500 First Interstate Center
999 Third Avenue
Seattle, Washington 98104

Prepared For:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

FINAL
SITE INSPECTION REPORT
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

TABLE OF CONTENTS

Table of Contents (Cont.)

LIST OF APPENDICES

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

Ecology and Environment, Inc., (E & E) was tasked by the U.S. Environmental Protection Agency (EPA) to provide technical support for the completion of a Site Inspection (SI) at the former NIKE Missile Launch Site #81 (NIKE)(CERCLIS ID No. WA0001414184), located near Poulsbo, Washington. E & E conducted SI activities under Technical Direction Document No. 96-11-0007, issued under EPA Region 10 Superfund Technical Assessment and Response Team (START) Contract Number No. 68-W6-0008. The specific goals for the SI are provided below:

- Determine the potential threat to public health or the environment, and assess whether early action/removal activities are appropriate for the site;
- Determine the potential for a release of hazardous substances into the environment; and,
- Provide EPA with adequate information to determine whether the site is eligible for placement on the National Priorities List.

Activities conducted as a part of this SI included: reviewing previous information concerning the site; gathering new information; conducting sampling activities; mapping the site and sample points; and preparing an SI report summarizing the findings. The SI sampling event was intended to be a limited investigation of certain potential on-site contaminant sources and environmental receptors at and near the site.

This document includes a discussion of background information regarding the NIKE site and its environs (Section 2); a description of field activities and analytical protocol (Section 3); quality assurance/quality control procedures (Section 4); a description of source sampling and analytical results (Section 5); a discussion of migration exposure pathways and targets (Section 6); a summary of investigation findings and conclusions (Section 7); and a list of references (Section 8).

2. SITE BACKGROUND AND HISTORY

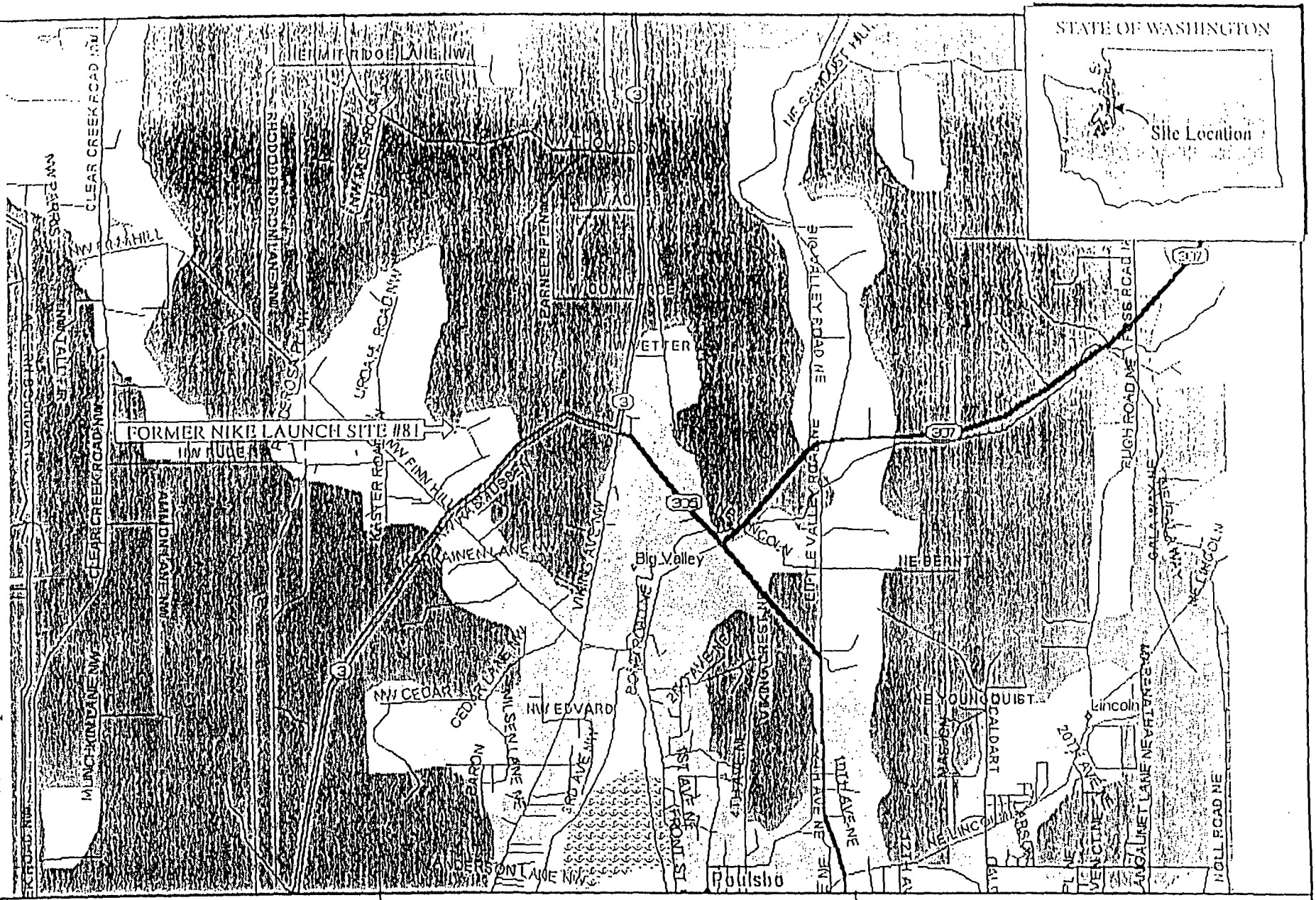
2.1 SITE LOCATION AND DESCRIPTION

The NIKE site is an inactive U.S. Army NIKE Ajax missile launch facility located northwest of Poulsbo, Washington city limits on the north side of Finn Hill Road (Figure 2-1). The site originally consisted of 81.91 acres of level and sloping ground containing three missile launch silos, a generator building, a missile assembly building, a missile fueling station (acid fueling station), a maintenance shop consisting of two sheds, a barracks, and a well house (Figure 2-2). The site is fenced with a gated entrance off Finn Hill Road.

The site was constructed by the U.S. Army on land obtained via acquisitions in fee, easements, and licenses made between 1955 and 1959 (USAED 1985). Disposal of the property occurred between 1966 and 1980 by various means, with 35.37 acres containing facility structures conveyed by the U.S. General Services Administration to (b) (6) in February 1967 (USAED 1985). (b) (6) used the property for 2-3 years for horse and cattle pasturage, and added on to the assembly building which he rented for approximately 1.5 years. (b) (6) is deceased, and First Western Investments (FWI) currently represents his estate, which retains ownership of the site. The property is bordered on the north, northeast, west, and southwest primarily with undeveloped and residential land. The site is bordered on the southeast by State Route 3 and the city of Poulsbo.

2.2 SITE OPERATIONS AND WASTE CHARACTERISTICS

Information regarding site-specific operations and waste characteristics for the period that the site was an active facility is incomplete. However, a report prepared by Law Environmental Services (LES) for the U.S. Army Corps of Engineers titled "*The NIKE Missile Site Investigation Program*" (not dated) is available which describes general activities at NIKE Ajax missile sites across the nation. Information contained in this report will be used to supplement the site history.



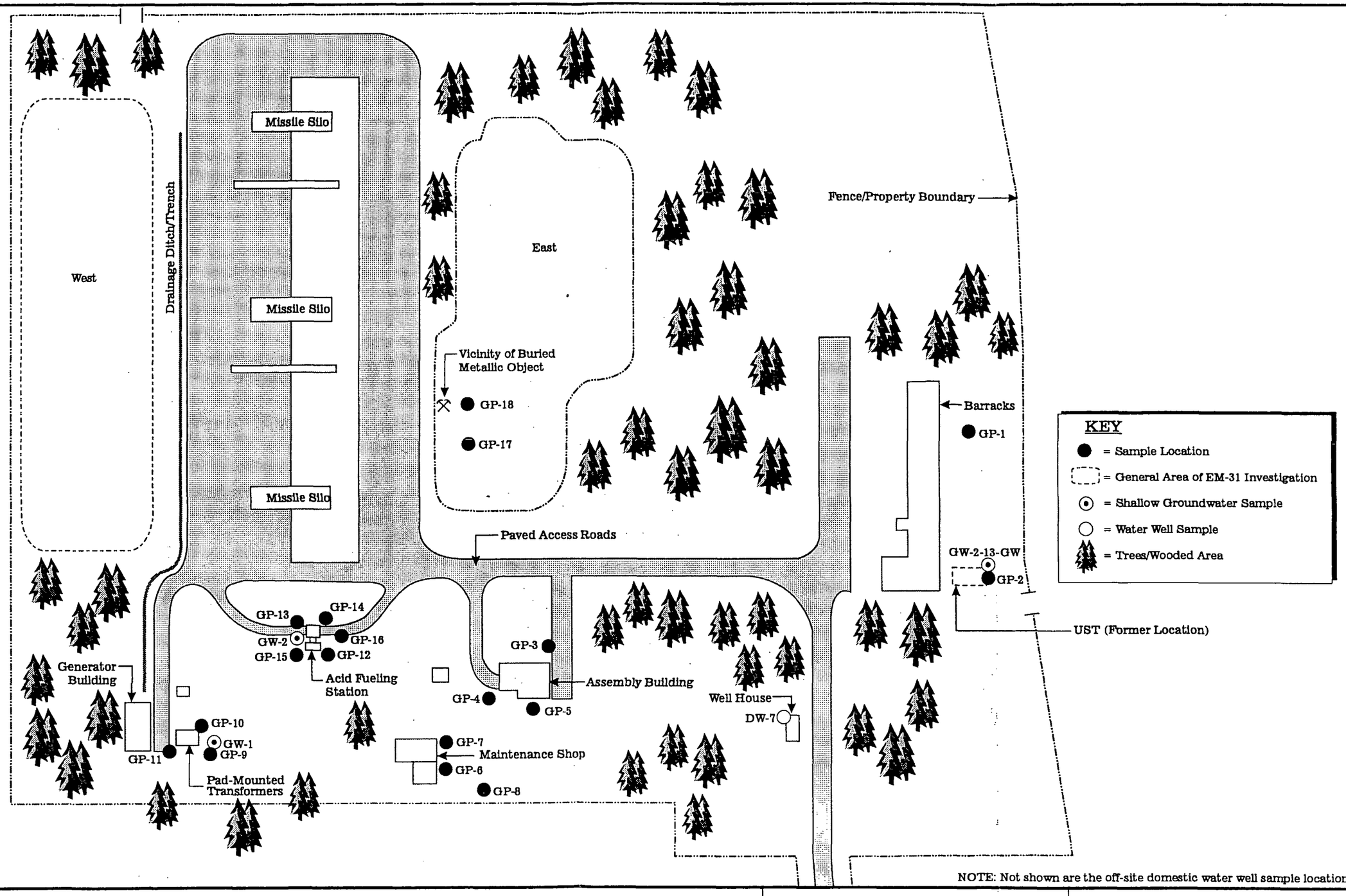
ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

FORMER NIKE LAUNCH SITE #81

FIGURE 2-1
SITE LOCATION MAP

SCALE: 1 INCH = 1/2 MILE (APPROX)

Drawn By:	Date	IDD/Job No.	Dwg. No.
MRE	10-11-96	AG1301SADO	AG1301F1



NOTE: Not shown are the off-site domestic water well sample locations.

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

Drawing Not to Scale

FORMER NIKE MISSILE
LAUNCH SITE #81
Poulsbo, Washington

Figure 2-2
SITE SAMPLING LOCATIONS

Drawn By:	Date	TDD/Job No.	Dwg. No.
MRE	2-21-97	AK0701SITO	AG1301F8

An aerial photograph review of the site revealed the presence of several buildings and roads in 1956 (E & E 1996c). It is assumed that operations at the site began in this year. NIKE Ajax missiles were deployed by the U.S. Army throughout the continental United States to protect major metropolitan areas and strategic military installations from aerial attack (LES, Not dated).

Missiles and warheads were assembled, maintained, prepared for firing, and stored at the Launch area of a NIKE site, with each of these activities being conducted at a separate building or location at the site. Missiles were fueled at outdoor fueling stations with acidic liquid fuels including inhibited red fuming nitric acid (IRFNA), unsymmetrical dimethyl hydrazine (UDMH), aniline/furfuryl alcohol, and ethylene oxide, all of which are highly toxic. In addition, battery electrolyte, potentially containing lead, reportedly was discarded at fueling stations on NIKE sites (LES, Not dated). Missile assembly operations involved the use of various solvents, anticorrosion products, and paints (LES, Not dated). Missile assembly buildings also were equipped with a full-length waste fluid collection system and associated underground drainfield (LES, Not dated). The presence of such a drainage system at the site has not been confirmed, however, records of the sale of site property list as a line item asset a waste sewer system containing 250 lineal feet of drain line for acid (McLeod 1967). The location of this system is not provided and, if present at the site, may be associated with either the missile assembly building or with the acid fueling station. Maintenance of the missile batteries in a combat ready status required the storage, handling, and disposal of missile components as well as solvents, fuels, hydraulic fluids, paints, and other materials required for support functions (LES, Not dated).

Three co-located subterranean missile launch silos are present at the NIKE site. The silos extend to approximately 25 feet below ground surface (bgs) and once contained operable elevators for access (currently inactive). One missile magazine is associated with each silo. Typically, NIKE magazines contained a floor drainage system which permitted waste materials to be washed to a central sump located under the silo elevator shaft (LES Not dated). As a general practice at NIKE sites, solvents, paints, and hydraulic fluid were washed to the sumps (LES Not dated).

A septic system consisting of a 12,000 gallon septic tank and drainfield with 1,110 lineal feet of sewer line was once present near the barracks (McLeod 1967). Battery electrolyte may have been disposed of to the septic system, as may have wastes requiring disposal during the facility deactivation process (LES, Not dated).

At one time seven transformers were located on site: three platform-mounted near the site access road, three pad-mounted near the generator building, and one pole-mounted near the barracks. The three platform-mounted transformers and the pole-mounted transformer were found to contain

polychlorinated biphenyls (PCBs) in excess of 50 parts per million (ppm), and were removed from the site (ERM 1992) (see discussion Section 2.3).

Also, four underground storage tanks (USTs) containing fuel oil once existed at the site: one at the missile assembly building, two at the generator building, and one at the barracks (WSI 1993). A discussion of tank removal activities is provided in Section 2.3.

2.3 PREVIOUS SITE CHARACTERIZATIONS

In August 1985, the U.S. Army Engineer District, Seattle, conducted a survey of the site under the Defense Environmental Restoration Program (DERP). This survey determined that the site was essentially as the Army had left it in 1967 and that all NIKE-era structures on the property had been used my (b) (6) for various purposes. The survey concluded that because all site facilities had been used by the current property owner, and because the property owner did not express an interest in having remedial work done under DERP, no further action was required (USAED 1985).

In August 1992, a consultant to the U.S. Army Corps of Engineers, Seattle District (USACE) provided permanent closure services for the four USTs previously used to store fuel. Two 2,000-gallon USTs (81L-2 and 81L-3) were associated with the generator building, one 500-gallon UST (81L-4) was associated with the missile assembly building, and one 2,000-gallon UST (81L-5) was associated with the barracks. Soil samples collected adjacent to the USTs were submitted for gasoline-, diesel-, and oil-range petroleum hydrocarbons; benzene, toluene, ethyl benzene, and xylenes. Fixed laboratory analytical results revealed fuel-related soil contamination at both USTs near the generator building and also at the UST near the barracks. Fifteen cubic yards of contaminated soil were removed from around one UST (81L-2) at the generator building. No other contaminated soils were removed. All USTs were excavated, emptied of contents, cleaned, and the contents and USTs disposed off-site. Excavated soils were stockpiled at the site (WSI 1993).

In September 1992, a consultant for FWI completed a Phase I and II environmental site assessment of the site. During this investigation, samples were collected from on-site structures of materials suspected of containing asbestos. Analytical results indicated the presence of asbestos in the hard fittings on the piping system in the bathroom of the missile assembly building, in all rooms in the barracks, in insulation on a large tank in the boiler room of the barracks, and in the vinyl floor tile and associated mastic in the barracks (ERM 1992). Further, insulation of power cables in the floor of the generator building, possibly containing asbestos, was not sampled because the power to these cables may still have been connected (ERM 1992). Also, although not sampled due to access limitations, asbestos was suspected to be present in the entry door to each missile silo, as well as in

the wall spacers inside the frame walls of the generator building (ERM 1992). Reportedly, all aboveground asbestos-containing material has been abated (E & E 1996c).

Also as a part of this investigation, soil samples of areas suspected of containing hazardous substances were collected. Soil samples submitted for analyses included one three-part composite sample of soils in the drainage ditch adjacent to the silos collected from 0 to 12 inches bgs (SP-1), one composite sample each of soils adjacent to the north (MS-1) and east (MS-2) sides of the northern maintenance shed, and one sample (ST-1) from beneath a drainage pipe associated with the barracks septic system. All four samples were submitted for volatile organic compound (VOC) analyses (EPA Method 8240). Samples SP-1, MS-1, and ST-1 were submitted for hydrocarbon identification and quantification (WDOE Method HCID-WTPH), with diesel detected in SP-1 at a concentration of 290 ppm and 2-butanone detected in MS-1 at a concentration of 0.52 ppm (E & E 1996). Samples SP-1 and ST-1 were also analyzed for chromium and total lead (ERM 1992), with concentrations in SP-1 at 17 ppm and 18 ppm respectively, and chromium detected in ST-1 at a concentration of 21 ppm (E & E 1996).

In September 1995, the three pad-mounted and the three platform-mounted transformers were sampled and analyzed for halogenated organic compounds (HOCs) (EPA Method 9076 - modified) and PCBs (EPA Method 8080). In October 1995, the pole-mounted transformer was also sampled and analyzed for HOCs (Method ASTM D-808) and PCBs (EPA Method 600/4-81-045). Analytical results indicated that the three platform-mounted and the pole-mounted transformers contained PCBs above 50 ppm to 157 ppm, and that the three pad-mounted transformers contained less than 1 ppm of PCBs. The concentration of HOCs detected in the platform-mounted transformer ranged from 126 to 206 ppm, the pole-mounted transformer contained 480 ppm of HOCs, and the three pad-mounted transformers contained less than 100 ppm of HOCs. In February 1996, the four PCB transformers were manifested off-site for disposal (Reynolds 1996).

Also, in September 1995, the USACE excavated four test pits in or adjacent to the former location of UST 81L-2 at the generator building (USACE 1995). At least one soil sample was collected from each pit for fixed laboratory analyses of gasoline-, diesel-, and oil-range petroleum hydrocarbons; benzene, toluene, ethyl benzene, and xylene; and total lead (USACE 1995). The results of these analyses were not available at the time this report was completed. Reportedly, the fifteen cubic yards of soil previously excavated from this location were transported to an off-site disposal facility in conjunction with this sampling effort (Bilodeau 1996). No additional work was conducted for contaminated soils adjacent to 81L-3 or 81L-5 because one UST was determined not to require further investigation under State of Washington UST regulations, and the other could not be re-located (Bilodeau 1996). A draft request for partial closure of USTs at the site was submitted by

the USACE to the Washington State Department of Ecology on September 27, 1996 in an Independent Remedial Action report (Bilodeau 1996).

In November 1995, a consultant for FWI collected three water samples, one from each silo. Approximately 17 feet of water, or an estimated 240,070 gallons, was present in each silo. Composite samples consisting of 50% of water taken from the surface and 50% of water taken from the bottom of the water column were collected. The samples were analyzed for total petroleum hydrocarbons (TPH)(EPA Method 418.1), VOCs (EPA Method 624), PCBs (EPA Method 8080), and priority pollutant metals (EPA Method 6010 except for mercury which was by cold vapor extraction)(Becker 1996). Concentrations of TPHs were below 0.2 parts per billion (ppb), and no VOCs were detected in any of the samples (E & E 1996). Concentrations of PCBs were detected in all three samples in the 0.8 to 0.9 ppb range, and concentrations of both total and dissolved lead, copper, and zinc were also detected in all three samples.

In September 1996, water in the silos was pumped out by this consultant to an irrigation line laid out in the field northwest of the drainage ditch. In April 1996, lead-based paint in the bathroom of the officers quarters (in the barracks) and in the bathroom of the missile assembly building was removed and placed in 55-gallon drums by a consultant to FWI.

On October 8, 1996, the START met with (b) (6), a member of the (b) (6) family, and (b) (6), a planning consultant to FWI at the site. A walk-through of all on-site structures was conducted with the exception of the missile silos, because the elevators to the silos have not been operational since the transformers were removed.

3. FIELD ACTIVITIES AND ANALYTICAL PROTOCOL

Field activities for the NIKE SI were conducted by START members from December 16, through December 20, 1996. Prior to mobilizing to the site, START contacted (b) (6) (FWI) and (b) (6) to arrange for site access and to discuss the scope of field activities. A description of the SI field work, including: site activities; sampling rationale; sample types, quantities, and locations; and samples collection methods, is presented in the following section. START re-mobilized to the site on January 14, 1997 with a subcontractor (for one day) to remove the inoperable submersible pump from the on-site well to allow for well water sample collection.

A total of 43 soil samples and ten water samples (including background samples) were collected during the SI. A list of sample identification numbers, sample depths, collection dates and times, and a brief description of sample locations and characteristics is provided in Table 3-1. Field activities were conducted in accordance with a Sampling and Quality Assurance Plan (SQAP) that was approved by the EPA Task Monitor and EPA Laboratory QA personnel prior to conducting field activities (E & E 1996c). The number of samples collected and the specific sample locations were dependent upon actual conditions encountered upon arrival to the site. Deviations from the SQAP were discussed with the EPA Task Monitor as they were encountered and are described below. Photographic documentation of site activities is provided in Appendix A.

3.1 SAMPLE LOCATIONS AND METHODOLOGIES

The general areas of sample locations were determined prior to field activities based upon existing file information and information contained in the Preliminary Assessment (E & E 1996b). Specific sample numbers and locations were determined in the field based upon site observations and sampling conditions. Sample locations for potential sources are provided in Figure 2-2 (Section 2). Target sample locations are provided in Figure 6-1 (Section 6).

In the event that insufficient sample recovery was achieved for all the analytical methods intended, additional boreholes immediately adjacent to the original borehole were installed. Sampling intervals in the subsequent borehole were identical to those in the original borehole, which are

TABLE 3-1

SAMPLE COLLECTION AND ANALYTICAL SUMMARY
FORMER NIKE MISSILE LAUNCH SITE
POULSBO, WASHINGTON

Sample Type	E&E Sample Number	Sample Depth (in feet)	Collection Date	Collection Time	Analytical Protocol	Location/Description
SOIL	GP-1-4	0-2	12/16/96	1040	VOC, SVOC, Pest/PCB, Total Metals	Behind barracks (background sample)
	GP-1-7	5-7	12/16/96	1045		
	GP-2-13	11-13	12/16/96	1250	WTPH-D	Behind Barracks near former UST
	GP-3-2	0-2	12/16/96	1510	VOC, SVOC, Pest/PCB, Total Metals	North side of missile assembly building
	GP-3-7	5-7	12/16/96	1530		
	GP-4-2	0-2	12/16/96	1600	VOC, SVOC, Pest/PCB, Total Metals	Southwest of missile assembly building
	GP-4-4	2-4	12/16/96	1610		
	GP-4-7	5-7	12/16/96	1455		
	GP-5A-2 GP-5B-2	0-2	12/17/96	0950	VOC, SVOC, Pest/PCB, Total Metals	South of missile assembly building
	GP-5A-7 GP-5B-7	5-7	12/17/96	1015		
	GP-6A-2 GP-6B-2 GP-6C-2	0-2	12/18/96	1100	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	East of maintenance shop
	GP-6A-7 GP-6B-7 GP-6C-7	5-7	12/17/96	1130		
	GP-7A-2 GP-7B-2 GP-7C-2	0-2	12/17/96	1225	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	Northeast of maintenance shop
	GP-7A-7 GP-7B-7 GP-7C-7	5-7	12/17/96	1240		
	GP-8A-2 GP-8B-2 GP-8C-2	0-2	12/18/96	1315	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	East of maintenance shop
	GP-8A-7 GP-8B-7 GP-8C-7	5-7	12/17/96	1335		
	GP-9-2	0-2	12/17/96	1455	Pest/PCB	Southeast of transformer pad located near the generator building
	GP-9-7	5-7	12/17/96	1500		

TABLE 3-1

SAMPLE COLLECTION AND ANALYTICAL SUMMARY
FORMER NIKE MISSILE LAUNCH SITE
POULSBO, WASHINGTON

Sample Type	E&E Sample Number	Sample Depth (in feet)	Collection Date	Collection Time	Analytical Protocol	Location/Description
SOIL (Cont'd.)	GP-10-2	0-2	12/17/96	1505	Pest/PCB	Northeast of transformer pad located near the generator building
	GP-10-7	5-7	12/17/96	1510		
	GP-11-2	0-2	12/17/96	1525	Pest/PCB	Southwest of transformer pad located near the generator building
	GP-11-7	5-7	12/17/96	1535		
	GP-12A-2 GP-12B-2	0-2	12/18/96	0850	VOC, SVOC, Pest/PCB, Total Metals	Southeast of the missile fueling station area
	GP-12A-7 GP-12B-7	5-7	12/18/96	0910		
	GP-13A-2 GP-13B-2	0-2	12/18/96	0935	VOC, SVOC, Pest/PCB, Total Metals	Northwest portion of the missile fueling station area
	GP-13A-7 GP-13B-7	5-7	12/18/96	0950		
	GP-14-2	0-2	12/18/96	1025	VOC, SVOC, Pest/PCB, Total Metals	Northeast portion of the missile fueling station area
	GP-14-4	2-4	12/18/96	1030		
	GP-14-7	5-7	12/18/96	1035		
	GP-14-8	7-8	12/18/96	1045		
	GP-15-2	0-2	12/18/96	1110	VOC, SVOC, Pest/PCB, Total Metals	Southwest portion of the missile fueling station area
	GP-15-4	2-4	12/18/96	1120		
	GP-15-7	5-7	12/18/96	1130		
	GP-15-8	7-8	12/18/96	1145		
	GP-16-2	0-2	12/18/96	1215	VOC, SVOC, Pest/PCB, Total Metals	East portion of the missile fueling station area
	GP-16-7	5-7	12/18/96	1230		
	GP-16-9	7-9	12/18/96	1245		
	GP-17-2	0-2	12/18/96	1255	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	Southwest portion of the east survey area (directly south of anomaly)
	GP-17-7	5-7	12/18/96	1320		
	GP-17-9	7-9	12/18/96	1340		
	GP-18-2	0-2	12/18/96	1400	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	Southwest portion of the east survey area (south of GP-17)
	GP-18-4	2-4	12/18/96	1420		
	GP-18-8	6-8	12/18/96	1435		

TABLE 3-1

SAMPLE COLLECTION AND ANALYTICAL SUMMARY
FORMER NIKE MISSILE LAUNCH SITE
POULSBO, WASHINGTON

Sample Type	E&E Sample Number	Sample Depth (in feet)	Collection Date	Collection Time	Analytical Protocol	Location/Description
WATER	GW-1	5	12/19/96	0910	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Shallow groundwater sample collected south of transformer pad
	GW-2	7	12/19/96	1100	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Shallow groundwater sample collected in missile fueling station area
	GW-2-13-GW	15	12/16/96	1300	VOC	Shallow groundwater sample collected from barracks (near a former UST)
	DW-1	Unknown	12/16/96	1316	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Upgradient domestic water well sample (used as back-ground)
	DW-2	Unknown	12/16/96	1410	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Downgradient domestic water well sample
	DW-3	Unknown	12/16/96	1425	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Downgradient domestic water well sample
	DW-4	Unknown	12/17/96	0900	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Downgradient domestic water well sample
	DW-5	Unknown	12/17/96	0925	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Downgradient domestic water well sample
	DW-6	Unknown	12/17/96	1400	VOC, SVOC, Pest/PCB, Total Metals, WTPH-D	Downgradient domestic water well sample
	DW-7	92	1/14/97	1200	VOC, SVOC, Pest/PCB, Total Metals, WTPH-G/D	Sample collected from the former on-site domestic water well

Key:
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds
Pest/PCB - Pesticide and PCBs
WTPH-G/D - Total Petroleum Hydrocarbons - Gasoline/Diesel
"A" "B" "C" - Designation of original and additional adjacent borehole(s) used when insuffient sampling material was recovered.

identified by the designation "A". The subsequent boreholes are designated "B" or "C" depending on the number of additional boreholes required.

The following sections describe matrix-specific sample locations and rationale, and sampling methodologies employed.

3.1.1 Surface and Subsurface Soil Samples

Of the 43 soil samples collected during the SI, 17 were surface soil samples collected from 0-2 feet bgs, while the remaining 26 were subsurface soil samples collected from depths greater than two feet bgs. The subsurface soil samples were collected in two foot intervals to depths that varied from borehole to borehole in order to recover enough sample material to meet all the required analytical methods. The samples were collected from a total of 18 Geoprobe™ borings at potential source areas, and included one boring drilled behind the north end of the barracks where two samples were collected for background analyte concentrations (Figure 2-2).

Grass, leaves, other organic material, debris, and large pieces of gravel (when present) were removed from all subsurface soil samples before being placed into sample containers. Samples were collected using a dedicated stainless steel sampler. The portion of each sample selected for VOC analysis was collected prior to homogenization in a dedicated aluminum pan using a dedicated stainless steel spoon. Samples were stored on ice in coolers.

3.1.2 Shallow Groundwater Samples

During Geoprobe ™ sampling efforts, a shallow (perched) groundwater table was encountered in topographically lower areas of the site. As outlined in the SQAP (E & E 1996b), an attempt was made to collect shallow groundwater samples when groundwater was encountered at a depth of less than 15 feet bgs. Three shallow groundwater samples were collected from three different locations at the site (GW-1, GW-2, and GP-2-13-GW). GP-2-13-GW (GP-2) was collected from behind the barracks near the former heating oil UST. Only partial sample volumes could be recovered from this location at a depth of 15 feet bgs. Shallow groundwater samples GW-1 and GW-2 were collected from the former transformer area and acid fueling station, respectively. Enough water was recovered from these borings to analyze for the full suite of analyses required (see Section 3.2). The perched water level in these borings was approximately 7 feet bgs.

Samples were collected directly from a dedicated Geoprobe™ sampling rod (screened within the water zone) positioned in the water table zone. A peristaltic pump with replaceable dedicated tubing was used to pump the water into the proper sampling containers. Samples were stored on ice in coolers.

3.1.3 Domestic Water Well Samples

Seven domestic water wells were sampled during the SI. Five of the wells were active water wells located in a general downgradient location of the site (DW-2 through DW-6). DW-1 was collected upgradient of the site and was used as the background sample. DW-7 was collected from the former on-site water well located inside the well house. The wells were purged for a minimum of ten minutes and samples were collected from the outlet or spicket nearest to the well. Water temperature, conductivity, and pH measurements were not recorded.

3.2 ANALYTICAL PROTOCOL

The analytical protocol was based on hazardous substances known or suspected to be present at the site, and known or suspected to have been released to the environment from the site. All samples submitted for organic and inorganic analyses during field activities were submitted to CLP labs for fixed laboratory analyses with the exception of WTPH-G/D samples. All WTPH-G/D samples were submitted to an outside lab procured by E & E. Samples submitted for organic analyses (VOCs, SVOCs, Pest/PCBs) were shipped to CompuChem Environmental located in Research Triangle Park, North Carolina. Inorganic analyses were performed by Southwest Labs of Oklahoma in Broken Arrow, Oklahoma. WTPH-D/G analyses were performed by Columbia Analytical Services in Kelso, Washington. The analytical protocol was based on hazardous substances that may have been released into migration pathways at the site. See Table 3-1 for sample-specific analyses performed.

3.3 EM-31™ INVESTIGATION

Two heavily vegetated, undeveloped areas located to the west and east of the missile silos were examined using an EM-31™ electromagnetic conductivity device (see Figure 2-2). Historical photos revealed that the areas were once open, with little or no vegetation growing on them (there is no evidence that structures ever existed in the areas). At each area, a grid was established with 20 foot node spacings throughout the cleared areas. At each node, four readings were collected from two verticle dipole positions and two horizontal dipole positions. The orientations completed at each node were approximated to north-south and east-west positions. The depth range is typically 6 meters in the horizontal dipole position and 3 meters in the vertical dipole position. Included with the readings is an in-phase reading that provides an indication of metallic objects. Appendix B provides contoured plots of the typical conductivity values and in-phase readings for each area.

Conductivity readings from the area west of the missile silos did not indicate any disturbances or buried objects throughout the area investigated. Conductivities seemed consistent at approximately

4 to 5 millimhos/meter (mmho/m). The only significant anomalies were along a drainage ditch, which runs north-south along the western edge of the missile silos. A galvanized steel culvert is partially buried along this drainage ditch and accounts for the majority of the anomalous signals observed. The in-phase mode contour clearly depicts the culvert and shows its location, where it is apparently buried completely and not visible. These anomalies are shown as strong negative values contoured along the eastern edge of the surveyed area. The remaining area is voided of any metallic objects.

The area east of the missile silos also did not indicate any variations of conductivity, except an apparent gradual increase in more conductive soils to the north of the survey area. The south part of the survey area was relatively less conductive than the areas to the north, or compared to soils west of the missile silos. In-phase readings exhibited an anomalous signal near the southwest corner of the surveyed area at grid node 20,40 (north of Geoprobe™ boring locations GP-17 and GP-18 shown in Figure 2-2). This occurred only in the north-south position orientation, but not the east-west orientation. The readings indicated a very small metallic object (not even the size of a 55-gallon drum). The signals appeared as a discrete point rather than an anomaly that would normally be associated with a buried drum. The depth of the object was estimated to be less than 8 feet bgs. Soil samples were collected in the area south of the anomaly.

4. QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) data are necessary to determine precision and accuracy, and to demonstrate the absence of interference and/or contamination of sampling equipment, glassware, reagents, etc. Specific QC requirements for laboratory analyses are incorporated in EPA's CLP, Statement of Work for Organics (EPA 1994b) and in EPA's CLP, Statement of Work for Inorganics (EPA 1994a). These QC requirements or equivalent requirements were followed for analytical work on the NIKE SI.

4.1 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Quality assurance samples included field equipment rinsate blank and trip blank samples. One field equipment rinsate blank sample was collected from the Geoprobe™ split-spoon sampler following the sampling event, and one trip blank sample was shipped to the laboratory.

Laboratory quality control samples included duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples.

4.2 DATA VALIDATION

The EPA Region X QA Office in Seattle performed all of the CLP data validation, including data that had already been given an internal laboratory validation. The EPA Region X QA Office generated a data validation memorandum for their respective data reviews, discussing data usability and the laboratory's ability to meet internal and method QA/QC criteria. Further, E & E reviewed the data validation memorandum generated by the EPA to verify data usability qualifications. The results of this review and the data validation memoranda are provided with the laboratory data forms in Appendix C.

4.3 PROJECT-SPECIFIC DATA QUALITY OBJECTIVES

The laboratory data was reviewed to ensure that data quality objectives (DQOs) specified in the SQAP were met for the project. The laboratories' ability to meet the project DQOs for precision, accuracy, representativeness, comparability, and completeness is described below.

4.3.1 Precision and Accuracy

Precision and accuracy measures the reproducibility of the sampling and analytical methodology. Precision is defined as the relative percent difference (RPD) between duplicate samples analyses. Laboratory duplicate samples measure the precision of the analytical method; field duplicate samples measure the precision of the field and analytical methods. Accuracy is defined as the matrix spike percent recovery of the spiked samples' analyses. Laboratory MS/MSD samples and native spike samples measure the accuracy of the analytical method.

Laboratory MS/MSD samples were taken during the SI to measure the accuracy of the analytical methods. A review of the data indicates that QC criteria was met.

4.3.2 Representativeness

Data representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The number and selection of samples were determined in the field to accurately account for site variations and sample matrices. The DQOs for representativeness were met.

4.3.3 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Data produced for this site followed applicable field sampling techniques and specific analytical methodology. The DQOs for comparability were met.

4.3.4 Completeness

Data completeness is defined as the percentage of usable data (usable data divided by the total possible data). All laboratory data were reviewed for data validation and usability. The DQOs for completeness were met.

4.4 LABORATORY AND FIELD QA/QC PARAMETERS

Laboratory data was also reviewed for holding times. All sample analyses met holding time criteria. The complete data review can be found in the data validation and usability memoranda located in Appendix C. In general, the laboratory and field QA/QC were considered acceptable.

4.4.1 Laboratory Blanks

All laboratory blanks met the frequency criteria. No elevated concentrations of contaminants were detected in laboratory blanks.

4.4.2 Field Equipment Rinsate Blanks

Equipment rinsate blanks met frequency criteria. No contaminants of concern were detected in the rinsate blanks.

5. POTENTIAL SOURCE SAMPLING

Potential site sources, potential source sample locations, and analytical results are described in this section. A discussion of shallow groundwater and water well sample locations and analytical results is provided in Section 6. Analytical data forms from laboratory analyses are provided in Appendix C.

5.1 SOURCE DESCRIPTIONS

Potential contaminant sources investigated during the SI included:

- Surface and subsurface soils surrounding the former acid fueling station (potential drainfield);
- Surface and subsurface soils adjacent to the missile assembly building (potential drainfield);
- Surface and subsurface soils adjacent to the maintenance shop;
- Surface and subsurface soils adjacent to the existing concrete transformer pad located near the generator building;
- Surface and subsurface soils near the former barracks in the location of a former underground heating oil storage tank; and
- Surface and subsurface soils east of the missile silos.

5.2 SAMPLE LOCATIONS AND ANALYTICAL RESULTS

A total of 43 surface and subsurface soil samples were collected from potential source areas during this investigation (Figure 2-2). Tables 5-1 through 5-3 provide a summary of detected analytes. No VOC concentrations were detected above the method detection limit. Laboratory results indicating elevated concentrations of contaminants with respect to background concentrations are underlined in the tables (the background sample was collected from GP-1 behind the barracks), and all detected analytes are bolded in the tables. Elevated concentrations are those concentrations that are:

- Equal to or greater than the sample quantitation limit (SQL);
- Equal to or greater than the background sample SQL, when the background concentration is not detected, or

Table 5-1
SEMI-VOLATILE ORGANIC ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(ug/kg)

Analyte	Background		Missile Assembly Bldg. Area					Maintenance Shop Area					
	GP-1-4 JM194	GP-1-7 JM166	GP-3-2 JM195	GP-4-4 JM196	GP-4-7 JM168	GP-5-2 JM197	GP-5-7 JM169	GP-6-2 JM198	GP-6-4 JM170	GP-7-2 JM199	GP-7-7 JM171	GP-8-2 JM200	GP-8-7 JM172
Diethylphthalate	420 U	370 U	370 U	370 U	360 U	390 U	**84 JQ**	360 U	360 U	**240 JQ**	370 U	**150 JQ**	360 U
Di-n-butylphthalate	420 U	370 U	370 U	370 U	360 U	390 U	**49 JQ**	360 U	360 U	380 U	370 U	370 U	360 U
Fluoranthene	420 U	370 U	370 U	370 U	360 U	390 U	**40 JQ**	360 U	360 U	380 U	370 U	370 U	360 U
Chrysene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Benzo(b)fluoranthene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Benzo(k)fluoranthene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Indeno(1,2,3-cd)pyrene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Phenol	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
2-Chlorophenol	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
N-Nitroso-di-n-propylamine	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
1,2,4-Trichlorobenzene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
4-Chloro-3-methylphenol	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Acenaphthalate	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
2,4-Dinitrotoluene	420 U	370 U	370 U	370 U	360 U	390 U	380 U	360 U	360 U	380 U	370 U	370 U	360 U
Pyrene	**420 JQ**	370 U	370 U	370 U	360 U	390 U	**39 J**	360 U	360 U	380 U	370 U	370 U	360 U
bis(2-Ethylhexyl) phthalate	**120 JQ**	**52 JQ**	**120 JQ**	**100 JQ**	**49 JQ**	**52 JQ**	**60 JQ**	**76 JQ**	**56 JQ**	**86 JQ**	**67 JQ**	**82 JQ**	**59 JQ**

Table 5-1 (continued)
SEMI-VOLATILE ORGANIC ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(µg/kg)

Analyte	Acid Fueling Station Area										East Area			
	GP-12-2 JM204	GP-12-7 JM173	GP-13-2 JM174	GP-13-7 JM205	GP-14-2 JM206	GP-14-4 JM175	GP-15-4 JM207	GP-15-8 JM176	GP-16-2 JM208	GP-16-9 JM177	GP-17-2 JM178	GP-17-9 JM209	GP-18-4 JM210	GP-18-8 JM179
Diethylphthalate	380 U	380 U	390 U	120 JQ	230 JQ	390 U	180 JQ	390 U	160 JQ	360 U	380 U	160 JQ	50 JQ	56 JQ
Di-n-butylphthalate	66 JQ	380 U	390 U	63 JQ	380 U	390 U	380 U	390 U	49 JQ	360 U	380 U	380 U	39 JQ	48 JQ
Fluoranthene	100 JQ	380 U	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Chrysene	52 JQ	380 U	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Benzo(b)fluoranthene	80 JQ	380 U	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Benzo(k)fluoranthene	77 JQ	380 U	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Indeno(1,2,3-cd)pyrene	26 J	380 U	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Phenol	380 U	74 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
2-Chlorophenol	380 U	58 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
N-Nitroso-di-n-propylamine	380 U	41 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
1,2,4-Trichlorobenzene	380 U	39 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
4-Chloro-3-methylphenol	380 U	64 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Acenaphthalate	380 U	48 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
2,4-Dinitrotoluene	960 UJ	47 JQ	390 U	360 U	950 UJ	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
Pyrene	71 JQ	54 JQ	390 U	360 U	380 U	390 U	380 U	390 U	370 U	360 U	380 U	380 U	330 U	360 U
bis(2-Ethylhexyl)-phthalate	270 JQ	110 JQ	61 JQ	58 JQ	53 JQ	50 JQ	69 JQ	57 JQ	47 JQ	130 JQ	68 JQ	74 JQ	95 JQ	170 JQ

U - The analyte was not detected at or above the reported result.
JQ - The analyte was positively identified. The associated numerical result is an estimate and is less than the sample quantitation limit for the specific analyte in the sample.
NOTE: Sample depths are indicated by the last number in the listed sample numbers above (e.g. sample GP-5-7 was collected from Geoprobe™ boring GP-5, at 7 feet below ground surface).

recycled paper

ecology and environment

Table 5-2
PESTICIDE/PCBS ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(μg/kg)

	Background		Missile Assembly Bldg. Area				Maintenance Shop Area				Transformer Area
Analyte	*GP-1-7 JM166	*GP-1-4 JM194	GP-3-7 JM167	GP-4-7 JM168	GP-5-2 JM197	GP-5-7 JM169	GP-6-2 JM198	GP-6-7 JM170	GP-7-2 JM199	GP-8-2 JM200	GP-10-2 JM202
alpha-BHC	1.9 U	2.1 U	1.8 UJ	1.9 U	2.0 U	2.0 U	1.8 U	1.8 U	2.0 U	1.9 U	2.0 U
delta-BHC	1.9 U	2.1 U	1.8 UJ	1.9 U	2.0 U	2.0 U	1.8 U	1.8 U	2.0 U	1.9 U	2.0 U
gamma-BHC(lindane)	1.9 U	2.1 U	0.058 JQ	1.9 U	0.063 JQ	0.23 JQ	1.8 U	0.041 JQ	2.0 U	1.9 U	2.0 U
Heptachlor	1.9 U	2.1 U	1.8 U	1.9 U	0.26 JQ	0.46 JQ	1.8 U	1.8 U	2.0 U	1.9 U	0.19 JQ
Aldrin	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.34 JQ	2.0 U	2.0 U	2.0 U	1.9 U	2.0 U
Heptachlor Epoxide	1.9 U	2.1 U	1.8 U	1.9 U	2.0 U	2.0 U	1.8 U	1.8 U	2.0 U	1.9 U	2.0 U
Dieldrin	3.7 U	4.2 U	3.6 U	3.6 U	0.62 JQ	1.2 JQ	3.6 U	3.6 U	3.8 U	0.086 JQ	3.8 U
4,4' DDE	3.7 U	0.41 JQ	3.6 U	3.6 U	3.9 U	3.8 U	3.2 JQ	1.9 JQ	0.20 JQ	0.26 JQ	0.10 JQ
Endrin	3.7 U	4.2 U	3.6 U	3.6 U	0.85 JQ	3.8 U	3.6 U	3.6 U	3.8 U	3.7 U	3.8 U
4,4' DDD	0.13 JQ	4.2 U	3.6 U	0.090 JQ	0.45 JQ	3.8 U	0.19 JQ	0.18 JQ	3.8 U	3.7 U	3.8 U
4,4' DDT	3.7 U	0.69 JQ	3.6 UJ	3.6 U	0.58 JQ	3.8 U	5.1	3.8	3.8 U	8.1	3.8 U
Endrin ketone	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	0.19 JQ	3.8 U
Endrin aldehyde	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.7 U	3.8 U
alpha-Chlordane	1.9 U	0.14 JQ	1.8 U	1.9 U	0.074 JQ	2.0 U	1.8 U	3.6 U	0.24 JQ	0.23 JQ	0.13 JQ
gamma-Chlordane	1.9 U	210 U	1.8 U	1.9 U	0.12 JQ	2.0 U	1.8 U	3.6 U	2.0 U	1.9 U	0.12 JQ
Aroclor 1254	37 U	42 U	37 U	36 U	39 U	27 JQ	36 U	36 U	38 U	37 U	38 U

Table 5-2 (continued)
PESTICIDE/PCBS ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(µg/kg)

Analyte	Transformer Area		Acid Fueling Station Area							East Area			
	GP-11-2 JM203	GP-11-7 JM193	GP-12-7 JM173	GP-13-7 JM205	GP-14-2 JM206	GP-14-4 JM175	GP-15-4 JM207	GP-16-2 JM208	GP-16-9 JM177	GP-17-2 JM204	GP-17-9 JM209	GP-18-4 JM210	GP-18-8 JM179
alpha-BHC	0.073 JP	1.9 U	1.9 U	1.8 U	1.9 U	0.27 JQ	1.9 U	1.9 U	1.9 U	2.0 U	1.9 U	1.9 U	1.8 U
delta-BHC	2.0 U	0.16 JQ	1.9 U	1.8 U	1.9 U	0.10 JQ	1.9 U	1.9 U	1.9 U	2.0 U	1.9 U	0.069 JQ	1.8 U
gamma-BHC(lindane)	2.0 U	1.9 U	1.9 U	1.8 U	1.9 U	2.0 U	1.9 U	1.9 U	1.9 U	2.0 U	1.9 U	1.9 U	1.8 U
Heptachlor	0.15 JQ	1.9 U	1.9 U	1.8 U	1.9 U	2.0 U	1.9 U	1.9 U	1.9 U	2.0 U	1.9 U	1.9 U	1.8 U
Aldrin	2.0 U	1.9 U	1.8 U	1.8 U	1.9 U	2.0 U	1.9 U	1.9 U	1.9 U	2.0 U	1.9 U	1.9 U	0.62 JQ
Heptachlor Epoxide	2.0 U	1.9 U	0.40 JQ	1.8 U	1.9 U	0.22 JQ	1.9 U	0.11 JQ	1.9 U	0.13 JQ	1.9 U	1.9 U	1.8 U
Dieldrin	4.0 U	3.7 U	3.8 U	1.8 U	3.8 U	1.1 JQ	3.8 U	3.7 U	3.6 U	0.18 JQ	3.7 U	3.7 U	3.6 U
4,4' DDE	4.0 U	3.7 U	3.8 U	3.6 U	3.8 U	0.29 JQ	3.8 U	3.7 U	1.6 JQ	3.8 U	3.7 U	3.7 U	3.6 U
Endrin	4.0 U	3.7 U	3.8 U	3.6 U	3.8 U	0.74 JQ	3.8 U	0.31 JQ	3.6 U	3.8 U	3.7 U	3.7 U	3.6 U
4,4' DDD	4.0 U	3.7 U	3.8 U	3.6 U	3.8 U	0.31 JQ	3.8 U	3.7 U	3.6 U	0.28 JQ	3.7 U	3.7 U	3.6 U
4,4' DDT	4.0 U	3.7 U	0.25 JQ	3.6 U	3.8 U	1.1 JQ	3.8 U	3.7 U	1.1 JQ	3.8 U	3.7 U	3.7 U	3.6 U
Endrin ketone	4.0 U	3.7 U	3.7 U	3.6 U	3.8 U	3.7 U	3.8 U	3.7 U	3.7 U	3.8 U	3.7 U	3.7 U	3.6 U
Endrin aidehyde	4.0 U	3.7 U	3.7 U	3.6 U	3.8 U	3.7 U	3.8 U	3.7 U	3.7 U	0.23 JQ	3.7 U	3.7 U	3.6 U
alpha-Chlordane	2.0 U	1.9 U	3.8 U	1.8 U	1.9 U	2.0 U	1.9 U	0.32 JQ	0.13 JQ	2.0 U	0.11 JQ	1.9 U	1.8 U
gamma-Chlordane	2.0 U	1.9 U	3.8 U	0.23 JQ	0.24 JQ	2.0 U	0.12 JQ	0.19 JQ	1.9 U	0.26 JQ	0.12 JQ	1.9 U	1.8 U
Aroclor - 1254	40 U	26 JQ	38 JQ	38 U	36 U	39 U	38 U	37 U	36 U	37 U	37 U	37 U	37 U

U - The analyte was not detected at or above the reported result.
JQ - The analyte was positively identified. The associated numerical result is an estimate and is below the sample quantitation limit for the specific analyte in the sample.
NOTE: Sample depths are indicated by the last number in the listed sample numbers above (e.g. sample GP-5-7 was Geoprobe™ boring GP-5, at 7 feet below ground surface).

Table 5-3
TOTAL METALS ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE
POULSBO, WASHINGTON
(mg/kg)

Analyte	Background		Missile Assembly Bldg. Area						Maintenance Shop Area					
	GP-1-4 MJM864	GP-1-7 MJM865	GP-3-2 MJM868	GP-3-7 MJM869	GP-4-4 MJM871	GP-4-7 MJM872	GP-5-2 MJM873	GP-5-7 MJM874	GP-6-2 MJM875	GP-6-7 MJM876	GP-7-2 MJM877	GP-7-7 MJM878	GP-8-2 MJM879	GP-8-7 MJM880
Aluminum	17000	13000	18200	7650	18400	11000	12900	13500	13600	10800	20600	8210	17100	13700
Antimony	0.77 U	9.67 U	0.67 U	0.65 U	0.67 U	0.66 U	0.70 U	0.68 U	0.72 JL	0.66 U	0.72 JL	0.67 U	0.68 U	0.67 U
Arsenic	2.1	1.9	2.3	1.3	1.7	1.7	1.8	2.0	1.7	1.4	3.5	3.8	2.7	1.9
Barium	97.9	38.1	76.6	33.9	69.7	49.0	56.4	54.1	54.8	39.0	96.1	29.9	85.5	62.6
Beryllium	0.33	0.22 U	0.29	0.22 U	0.24	0.22 U	0.23 U	0.23 U	0.22 U	0.22 U	0.34	0.22 U	0.29	0.22 U
Cadmium	0.26 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.23 U	0.23 U	0.22 U	0.22 U	0.27	0.22 U	0.23 U	0.22 U
Calcium	2450	1360	2910	3190	2420	2540	2010	2980	1770	2300	2260	2220	2020	1840
Chromium	20.8	21.2	29.6	16.5	27.4	20.4	18.9	20.6	19.8	21.8	26.3	16.7	25.6	19.4
Cobalt	7.6	6.8	8.8	6.4	8.4	6.9	6.5	7.3	6.4	6.5	7.8	5.7	7.8	7.0
Copper	9.3	68.1	13.8	9.4	11.3	10.4	10	10.8	9.9	11.2	13.8	9.2	11.4	11.5
Iron	15100	14400	17000	12100	16400	12200	12400	13800	13100	11800	16600	11100	16800	12000
Lead	5.3	1.9	3.1	1.4	2.1	1.9	5.9	2.9	5.1	1.7	30.2	1.5	10.3 JL	2.4 JL
Magnesium	2940	4680	4340	3560	4630	4310	2990	3530	3660	3870	3700	3720	4010	3910
Manganese	572	209	243	202	221	214	239	242	174	189	350	296	400	193
Mercury	0.17	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.12 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Nickel	29.9	30.4	39.3	28.6	38.3	47.9	29.1	35,0	33.4	35.3	38.3	29.0	35.7	40.0
Potassium	326	412	480	392	452	329	286	438	235	385	332	325	321	352
Selenium	1.0 U	1.1 JH	0.90 U	0.87 U	0.90 U	0.88 U	0.93 U	0.91 U	0.99 JH	0.87 U	0.96 JH	0.89 U	0.91 U	0.90 U
Silver	0.26 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.23 U	0.23 U	0.22 U	0.22 U	0.23 U	0.22 U	0.23 U	0.22 U
Sodium	261	248	290	333	276	277	215	318	247	272	271	276	287	278
Thallium	1.2	0.45 U	0.47	0.53	0.55	0.67	0.53	0.63	0.45 U	0.78	0.89	0.66	1.4	0.89
Vanadium	40.5	38.5	43.2	27.0	45.5	29.6	33.6	36.1	34.1	29.3	39.9	29.1	42.1	27.6
Zinc	42.0	21.4	28.0	22.4	23.2	21.7	33.4	24.8	22.2	22.4	48.8	18.5	33.3	20.4

Table 5-3 (continued)
TOTAL METALS ANALYTICAL DATA SUMMARY
(SOURCE SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(mg/kg)

Analyte	Acid Fueling Station Area										East Area			
	GP-12-2 MJM888	GP-12-7 MJM889	GP-13-2 MJM890	GP-13-7 MJM891	GP-14-4 MJM866	GP-14-8 MJM867	GP-15-4 MJM881	GP-15-8 MJM882	GP-16-2 MJM883	GP-16-9 MJM884	GP-17-2 MJM885	GP-17-9 MJM886	GP-18-4 MJM893	GP-18-8 MJM892
Aluminum	15300	14700	12100	16400	17300	8800	15600	21900	18000	15500	16400	14900	12600	10100
Antimony	0.71 U	0.71 U	0.66 U	0.73 U	0.88 JL	0.72 U	0.68 U	0.77 U	0.69 U	0.66 U	0.68 U	0.67 U	0.67 U	0.66 U
Arsenic	2.9	2.0	2.3	2.4	2.5	1.7	3.7	3.5	2.9	2.4	2.3	2.0	2.1	1.8
Barium	68.3	33.7	44.9	58.0	74.3	27.2	69.6	61.7	56.1	50.2	54.5	58.4	44.3	30.4
Beryllium	0.25	0.24 U	0.22 U	0.28	0.37	0.24 U	0.27	0.34	0.31	0.23	0.29	0.26	0.22 U	0.22 U
Cadmium	0.57	0.24 U	0.22 U	0.24 U	0.65	0.24 U	0.23 U	0.26 U	0.23 U	0.22 U	0.23 U	0.22	0.22 U	0.22 U
Calcium	3190	2370	2810	2880	2370	2400	2730	2990	2940	23350	5420	2550	2500	2570
Chromium	24.6	24.9	24.7	25.8	44.4	21.3	47.5	32.9	25.1	23.3	29.0	23.2	25.8	20.4
Cobalt	7.9	8.5	7.2	7.5	19.8	5.9	7.8	8.7	8.1	10.5	7.9	8.3	7.9	6.1
Copper	13.4	13.0	11.2	10.3	12.5	8.7	13.3	13.6	12.2	10.4	9.9	10.5	12.1	10.4
Iron	15200	15600	13900	14800	22100	11300	15800	15500	17300	17600	15100	13900	14400	12900
Lead	17.4 JL	2.1 JL	7.3 JL	2.5 JL	4.2	1.3	6.3 JL	4.4 JL	6.9 JL	1.9 JL	4.3 JL	1.7 JL	1.9 JL	1.6 JL
Magnesium	4340	5220	4310	4080	18300	3100	4670	4430	4840	5900	4130	3750	4890	4320
Manganese	227	211	266	223	359	160	236	184	245	235	283	277	188	176
Mercury	0.12 U	0.12 U	0.11 U	0.12 U	0.12 U	0.12 U	0.11 U	0.13 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Nickel	36.6	47.5	34.9	41.8	271	32.6	44.2	44.8	46.8	107	37.1	37.2	41.2	36.1
Potassium	446	342	395	364	431	284	403	397	379	360	440	447	390	336
Selenium	0.94 U	0.95 U	0.88 U	0.97 U	1.2 JH	0.95 U	0.91 U	1.0 U	0.92 U	0.89 U	0.90 U	0.90 U	0.90 U	0.87 U
Silver	0.24 U	0.24 U	0.22 U	0.24 U	0.23 U	0.24 U	0.23 U	0.26 U	0.23 U	0.22 U	0.23 U	0.22 U	0.22 U	0.22 U
Sodium	353	271	303	316	267	271	343	335	320	297	342	338	314	274
Thallium	0.80	0.47 U	0.75	0.49 U	1.3	0.54	0.60	0.51 U	0.64	0.64	0.72	0.84	0.57	0.67
Vanadium	40.4	38.1	34.6	41.4	37.6	32.0	40.0	48.6	45.1	43.0	44.9	37.8	36.2	32.5
Zinc	51.7	24.8	27.0	21.1	28.8	16.3	36.4	28.0	33.8	24.6	25.2	20.6	21.8	19.

U - Analyte was not detected at or above the reported result. JL - Analyte was positively identified and contains a "low" bias". The associated numerical result is an estimate. JH - The analyte was positively identified and contains a "high bias". The associated numerical result is an estimate.

- At least three times greater than the background concentration when the background concentration equals or exceeds the detection limit.

When elevated concentrations of soil samples were evaluated, the background sample with the greater sample concentration was used. For duplicate sample sets, the highest concentration per analyte is the concentration used when determining whether the analyte concentration is elevated. For analytical results that are qualified as estimated, the sample concentration was adjusted as described in "Using Qualified Data to Document an Observed Release" (OSWER Publication 9285,7-14FS, June 1994) prior to determining whether the concentration is elevated. Estimated analytes not listed in this reference were not evaluated.

5.2.1 Former Acid Fueling Station

Five soil borings were drilled in the area around the former acid fueling station (GP-12 through GP-16). No elevated concentrations of VOCs, SVOCs, or Pesticide/PCBs were identified from laboratory analytical data. Elevated levels of various inorganic (total metals) compounds were identified in several of the samples collected in the former acid fueling station. Elevated analytes consisted of cadmium, lead, magnesium, and nickel. Of these, the cadmium concentrations slightly exceeded detection limits. The concentration of lead in sample GP-12-2 9 (17.4 ppm) is significantly less than the OSWER soil lead guidance level of 400 ppm, concentrations of nickel in samples GP-14-4 (271 ppm) and GP-16-9 (107 ppm) are less than the EPA Region III Risk Based Concentration (RBC) of 1,600 ppm for residential areas, and magnesium was detected at a concentration of 18,300 ppm in sample GP-14-4. Magnesium, however, is a common, naturally-occurring metal, and no RBC or other guidance level exists. (see Table 5-3).

5.2.2 Missile Assembly Building Area

Three soil borings were drilled adjacent to the former missile assembly building (GP-3, GP-4, and GP-5). No elevated concentrations of VOCs, SVOCs, Pesticide/PCBs, or total metals were identified from laboratory analytical data (see Table 5-3).

5.2.3 Maintenance Shop Area

Three soil borings were drilled near the former maintenance shop located southwest of the missile assembly building (GP-6, GP-7, GP-8). No elevated concentrations of VOCs and SVOCs were identified in samples collected near the maintenance shop. Elevated levels of 4,4-DDT were detected in GP-6-2 (5.1 ppm), GP-6-7 (3.8 ppm), and GP-8 (8.1 ppm) at concentrations greater than

three times background concentrations (Table 5-2). These concentrations also exceed the Region III RBC of 1.9 ppm.

Elevated levels of cadmium and lead were identified in GP-7 at a depth of 0 to 2 feet, however the concentration of cadmium was only slightly above the dectection limit and the 30.2 ppm of lead is well below the OSWER soil lead guidance level of 400 ppm (Table 5-3).

5.2.4 Transformer Pad Area

Three soil borings were drilled adjacent to the transformer pad located near the generator building (GP-9, GP-10, and GP-11). Samples collected from these three borings were analyzed only for Pesticide/PCBs. No elevated concentrations were identified in the samples collected from these borings.

5.2.5 Former Barracks Area

One soil boring was drilled in an area near a former UST located on the southeast side of the barracks (GP-2). This soil boring was drilled at the request of the USACE to help determine if residual contamination existed in an area where a former heating oil UST was removed. One soil sample was collected from the boring at a depth of 13 feet bgs and analyzed for WTPH-G/D. Analytical results indicate that gasoline or diesel was not detected above the method reporting limit (5 ppm for gasoline and 25 ppm for diesel).

5.2.6 Area East of Missile Silos

Two soil borings (GP-17 and GP-18) were drilled in the southwest portion of the east survey area. The borings were located south of an anomaly (small metallic object) detected from an EM-31™ survey at a depth determined to be less than 8 feet bgs (see Section 3.3). No VOCs, SVOCs, or Pesticide/PCBs were identified in the borings. Low levels of diesel-range hydrocarbons (37 ppm) were identified in a sample collected 8 feet bgs in GP-18. Gasoline was not detected in GP-18. No gasoline or diesel was identified in GP-17.

One elevated concentration of cadmium was identified in GP-17 from 7 to 9 feet bgs, however this concentration was only slightly above the detection limit (Table 5-3).

6. MIGRATION/EXPOSURE PATHWAYS AND TARGETS

6.1 GROUNDWATER MIGRATION PATHWAY

The site is underlain by approximately 80 feet of glacial till deposited during the Vashon period (ERM 1992). Vashon till is typically impervious to groundwater flow except through thin, often discontinuous sand and gravel stringers. The Vashon till will cause precipitation to perch at or near the ground surface and may hold such waters in shallow depressions allowing the formation of wetlands (ERM 1992).

The Vashon till is underlain by the Puyallup Formation which consists of sand and gravel with some clay interbeds. The Admiralty Formation underlies the Puyallup Formation, which is a regional clay formation of varying thicknesses with low permeability to groundwater flow (ERM 1992).

Well logs of test borings in the area indicate that perched water occurs on the surface of the glacial till, at an average depth of 2.5 feet bgs (ERM 1992). A log of the on-site water supply well (unpublished data) indicates that the first groundwater aquifer occurs at a depth of approximately 103 feet bgs. Static water level in the well at that time was recorded at a depth of 93 feet bgs. The well was completed in a well-graded sand formation suggesting that it taps the Puyallup Formation (ERM 1992). This well was taken out of service when transformers supplying power to the well were removed (E & E 1996). During the SI, the static water level from the on-site well was measured at 92 feet bgs. Shallow (perched) water levels in the topographically lower areas of the site (near the transformer pad and acid fueling station) were measured from 5 to 7 feet bgs during drilling operations.

In 1994, subsurface exploration was performed at and adjacent to the site by Harza Northwest, Inc. A truck-mounted drill rig was used to drill eight widely spaced boreholes (Harza 1994). Three of the boreholes were drilled within or bordering the site. According to borehole logs, the upper 1.5 to 5 feet of surface soils at the site consist of loose to dense silty sand. Dense olive grey sand was encountered under the upper horizon at 5 feet bgs. The upper horizon was generally underlain by interbedded mottled silty sand, clayey sand, sand, and silty clay/clayey silt (Harza 1994). The horizon ranged in thickness from 2.5 to 3 feet thick. Very dense olive grey sand was

encountered from 8 feet bgs to approximately 20 feet bgs. A significant percentage of gravel and cobbles was encountered in all borings throughout the drilled intervals (Harza 1994). Similar soil conditions were encountered during the SI.

Seventeen municipal water systems are present within 4 miles of the site (EPA 1996). Eleven of these systems consist of one well serving a small community of less than 300 people. Four multiple well water systems have all wells in the same distance ring. The two remaining water systems with multiple wells (i.e., the City of Poulsbo and Naval Sub Base Bangor) have wells in more than one distance ring. The City of Poulsbo operates five wells serving approximately 2,745 people: three active, one standby, and one inactive (Strickland 1996). The Naval Sub Base Bangor operates six active wells serving a total population of 15,600 people (Pittman 1996). Water for these systems is blended and no one well contributes more than 40 percent to the water system (Strickland 1996)(Pittman 1996). For this reason, the population served by each well was apportioned by dividing the total population served by the number of wells in each system as follows:

- City of Poulsbo: total population 2,745 / 4 wells = 686.25 people per well; and
- Naval Sub Base Bangor: total population 15,600 / 6 wells = 2,600 people per well.

Twenty-nine known private drinking water wells exist within 4 miles of the site. The average number of persons per household for Kitsap county is 2.65 people (USDC 1990). The nearest well is located at a home approximately 0.25 mile south of the site (E & E 1996). Populations using groundwater for drinking water are summarized in Table 6-1.

6.1.1 Sample Locations

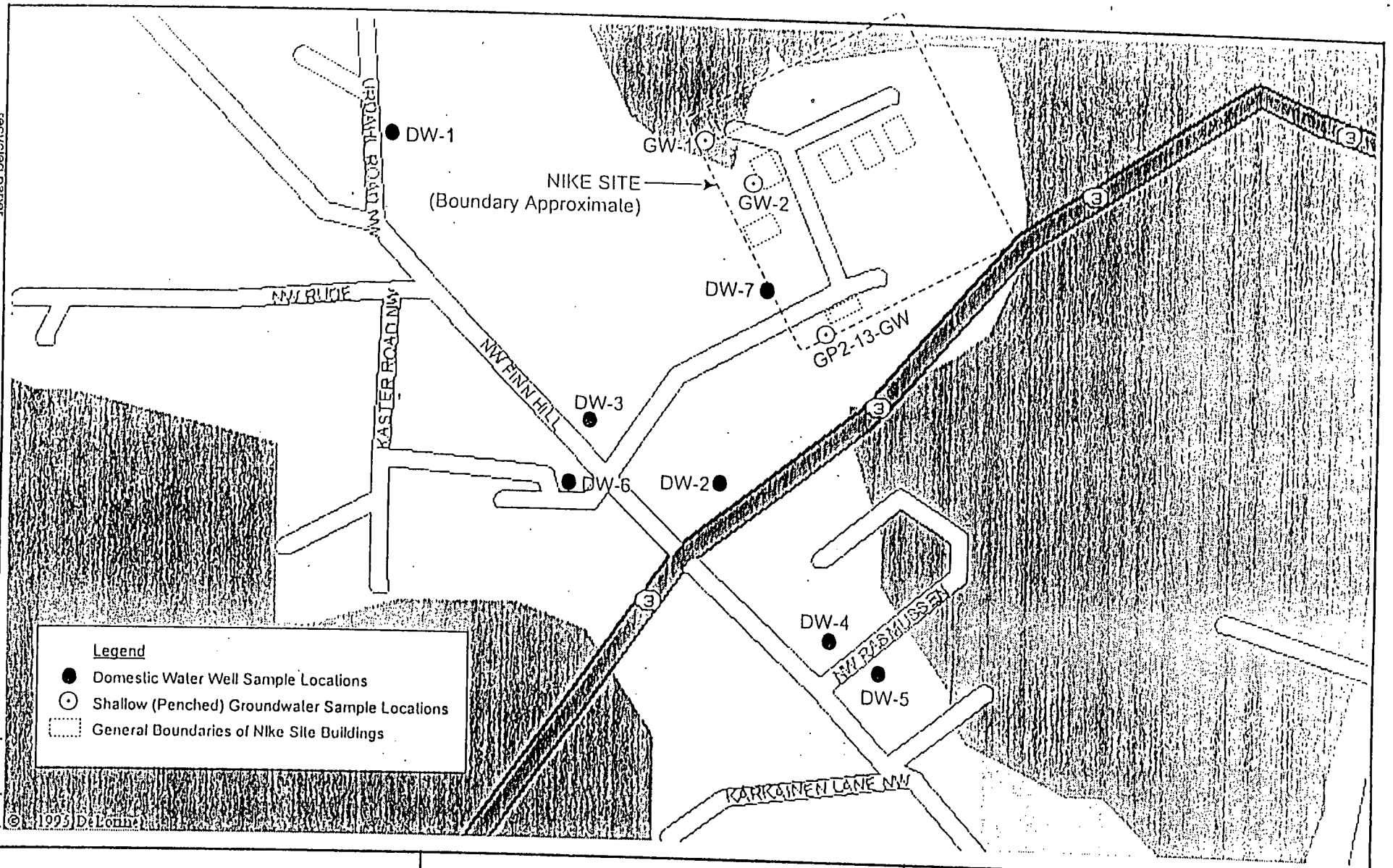
Three shallow (perched) groundwater samples (GW-1, GW-2, and GP-2-13-GW) and seven deep domestic drinking water well samples (DW-1 through DW-7) were collected to determine whether potential contaminant source areas may have impacted groundwater at and near the site (Figure 6-1).

DW-1 is the designated (upgradient) background sample, and DW-2 through DW-6 were all collected from domestic water wells in a general location downgradient to the site. DW-7 was collected from the former on-site drinking water well. A detailed summary of domestic well sample locations are given in Table 6-2.

Table 6-1
GROUNDWATER DRINKING WATER POPULATION WITHIN A 4-MILE RADIUS
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

Distance (Miles)	Well Identification	Well Population	Total Well Population per Distance Ring
0 - 1/4	Domestic Water wells (28)	74.2	770.45
	DW-2	8	
	DW-3	2	
	City of Poulsbo (DW-6 from bus Barn)	686.5	
1/4 - 1/2	DW-4	2	6
	DW-5	4	
1/2 - 1	DW-1	2.65	88.65
	Poulsbo Heights	43	
	Poulsbo Heights	43	
1 - 2	City of Poulsbo (2)	1,372.5	
	Back Forty Water System (2)	42	
	Pioneer Acres	30	
	Viewside Community Water	108	
	Vinland View (2)	56	1,609
2 - 3	City of Poulsbo (1)	686.25	
	Bela Vista	283	
	Gala Pines Water	180	
	Pioneer Hill West	45	
	Scandialand Mobile Home Park	81	
	Sherman Hill	15	1,290
3 - 4	Edgewater Estates (3)	1,186	
	Naval Sub Base Bangor (5)	13,000	
	Indian Hills Estates	110	
	Lincoln Hills Estates	31	
	Lofall Water	42	
	Rhododendron Mobile Home Park	56	14,425
Total			18,189

Source: EPA 1996; DOE 1997



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

FORMER NIKE MISSILE LAUNCH SITE #81
Poulsbo, Washington

Figure 6-1
GROUNDWATER SAMPLE LOCATION MAP

Drawing Not to Scale

Drawn By:	Date	TDD/Job No.	Dwg. No.
MRE	2-28-97	AG1301SADO	AG1301F9

Table 6-2
DOMESTIC WATER WELL SAMPLE LOCATIONS/DESCRIPTIONS
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

Well Number	Well Owner	Proximity to NIKE Site
DW-1 (Upgradient Background Well)	(b) (6) (b) (6) Urdahl Road Poulsbo, WA	Approximately 0.5 mile north-west of NIKE site.
DW-2	(b) (6) Accumar Corporation (b) Finn Hill Road Poulsbo, WA	Approximately 0.35 mile south-west of NIKE site.
DW-3	(b) (6) (b) (6) Finn Hill Road Poulsbo, WA	Approximately 0.25 mile south of the NIKE site.
DW-4	(b) (6) (b) Northwest Rasmussen Court Poulsbo, WA	Approximately 0.65 miles south of the NIKE site.
DW-5	(b) (6) (b) Northwest Rasmussen Court Poulsbo, WA	Approximately 0.70 miles south of the NIKE site.
DW-6	City of Poulsbo Bus Barn Facility Poulsbo, WA	Approximately 0.35 yards south of the NIKE site.
DW-7	Former On-site Well NIKE site Well House	On Site

6.1.2 Analytical Results

SVOCs and Pesticide/PCBs were not detected in any of the water samples collected during the SI. Laboratory analytical results for detected VOCs and total metals in water samples collected from the shallow (perched) groundwater and domestic water wells are provided in Tables 6-3 and 6-4. Elevated concentrations are underlined in the tables. Only those analytes that were elevated in a source area at the site were evaluated in groundwater samples. Elevated concentrations were detected only in DW-7, GW-1, and GW-2. Lead and nickel were detected in all three samples, with lead concentrations exceeding the MCL of 15 ppb in each, and nickel concentrations exceeding the MCL of 100 ppb in two of the samples. Magnesium was detected in two samples, but there are no MCLs or RBCs for this element. Cadmium was detected in two samples, but these concentrations only slightly exceeded the detection limits and were well below the MCL of 5 ppb (Table 6-4). It should be noted that all these concentrations were detected in groundwater samples collected from sources that are not used for drinking water, and that no elevated concentrations were detected in samples collected directly from drinking water wells.

Table 6-3
VOLATILE ORGANIC COMPOUNDS ANALYTICAL DATA SUMMARY
(GROUNDWATER SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(µg/L)

Analyte	Maximum Contaminant Level	GW-1 JM180	GW-2 JM181	Rinsate JM183	GP-2-13-GW JM184	DW-1 JM185 Background	Trip Blank JM225
Methylene Chloride	0.005	10 U	10 U	4 JQ	1 JQ	1 JQ	2 JQ
Acetone	NA	10 U	21 JK	10 U	17 JK	10 UJ	10 UJ
Chloroform	NA	10 U	10 U	10 U	10 U	10 U	27 JQ
Bromodichloromethane	NA	10 U	10 U	10 U	10 U	10 U	1 JQ
Trichloroethene	0.005	10 U	10 U	2 JQ	10 U	10 U	10 U
Toluene	1	1 J	10 U	10 U	10 U	10 U	10 U
Xylene (Total)	10.0	3 J	10 U	10 U	10 U	10 U	10 U

U - The analyte was not detected at or above the reported result.
UJ - The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample.
JQ - The analyte was positively identified. The associated numerical result is an estimate an is below the sample quantitation limit for the specific analyte in the sample.
JK - The analyte was positively identified. The associated numerical result is an estimate and the sample contains an "unknown" bias.
NA - Not Applicable.

NOTE: Shallow groundwater sample numbers begin with "GW" above, and domestic water well samples begin with "DW".

Table 6-4
TOTAL METALS ANALYTICAL DATA SUMMARY
(GROUNDWATER SAMPLES)
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON
(µg/L)

Analyte	MCL	DW-1 MJM858 (b) (6) (Bkgd)	DW-2 MJM859 (b) (6)	DW-3 MJM860 (b)	DW-4 MJM861 (b) (6)	DW-5 MJM862 (b) (6)	DW-6 MJM863 Poulsbo	DW-6 MJM887 Duplicate	DW-7 MJM958 NIKE	GW-1 MJM894 Transformer Pad	GW-2 MJM895 Acid Fueling Station	GW-RNS MJM896 Rinsate
Aluminum	50-200	34.3 U	25.4 U	31.0 U	24.1 U	25.5 U	54.4 U	26.2 U	43.7	179000	467000	52.2 U
Antimony	6.0	3.5 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	2.1	5.2 U	8.7 UJ	3.0 U
Arsenic	50	3.0 U	3.0 U	5.0	3.0 U	5.7	3.0 U	3.0 U	3.0 U	22.9	63.9	3.0 U
Barium	2,000	2.6	2.6	10.3	2.2	3.3	2.4	2.3	53.5	1100	4130	1.0 U
Beryllium	4.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5	11.6	1.0 U
Cadmium	5.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.1	1.0 U	1.6	1.0 U
Calcium	NA	10600	10900	18600	10200	12400	8940	8970	8230	35800	156000	84.4
Chromium	100	4.1	5.2	1.3	2.6	2.0	4.0	3.9	5.8	172	601	1.0 U
Cobalt	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.5	68.2	227	1.0 U
Copper	1,300	6.0	1.6	1.3	1.0 U	11.7	1.0 U	1.0 U	133	136	533	1.0 U
Iron	NA	10.0 U	92.5	14.8	17.8	14.8	19.2	10.0 U	33800	109000	310000	27.9
Lead	15	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	39.9	18.7	63.6	1.0 U
Magnesium	NA	8790	10100	7780	10100	11100	9840	9860	5530	30700	90700	22.0 U
Manganese	50	1.0 U	3.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	308	2380	3890	1.0 U
Mercury	2.0	9.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.24	0.20 U
Nickel	100	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	7.2	402	1220	1.0 U
Potassium	NA	681	943	1140	1080	1310	928	841	1330	6260	13700	41.0 U
Selenium	50	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	3.0 U	5.6	7.9	4.0 U
Silver	100	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Sodium	NA	5450	5760	6340	4650	5170	4490	4630	5770	10400	13800	326
Thallium	2.0	2.0 U	2. 0 U	3.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.8	8.0	5.5 JH	2.0 U
Vanadium	NA	5.4	6.3	5.9	5.1	7.2	6.0	6.0	5.1	294	913	1.0 U
Zinc	5,000	30 5	77.8	93.4	6.0 U	70.4	7.4 U	7.0	1920	173	646	8.9 U

U - The analyte was not detected above the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
JH - The analyte was positively identified and contains a "high" bias. The associated numerical result is an estimate.

DW-7 is the former on-site well, while GW-1 and GW-2 were collected from the shallow (perched) groundwater from the transformer area and acid fueling station area, respectively (water samples were collected from 5-7 feet bgs in both areas). Further, a diesel concentration of 322 ug/L was detected in sample GW-2. No other concentrations of diesel were identified.

6.2 SOIL EXPOSURE PATHWAY

Approximately 1,033 people reside within a 1 mile radius of the site. The closest home is located approximately 800 feet to the south. The site is fully fenced and gated with one main entrance located on the south side and two secondary entrances: one north of the missile silos and one east of the barracks. The gate for the entrance north of the silos has been removed. The remaining two gates are locked. No terrestrial sensitive environments are known to occur at the site (WDF&W 1996). Table 6-5 provides population figures for people residing within 1 mile of the site.

Table 6-5

POPULATIONS WITHIN A 1-MILE RADIUS
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

Distance Ring	Population
0 - 1/4 mile	84
1/4 - 1/2 mile	151
1/2 - 1 mile	798
Total	1,033

Source: EPA 1996; DOE 1997.

6.3 SURFACE WATER MIGRATION PATHWAY

The site is situated on a plateau on the western flank of the Big Valley River at an elevation of approximately 300 feet above mean sea level (ERM 1992; USGS 1981). According to borehole logs, the upper 1.5 to 5 feet of surface soils consist of loose to dense silty sand (Harza 1994). Similar conditions were encountered during the SI. The land surface at the site slopes south and southeast. The drainage ditch flanking the northern side of the missile perimeter road drains to a small wetland/pond. Liberty Bay, an inlet of Puget Sound, and the mouth of the Big Valley River are both located approximately one mile southeast of the site. An overland route from the site to this surface water body was not identified in the field.

The 2-year, 24-hour rainfall event for the area of the site is 2.5 inches (USDC 1973). The upgradient drainage area of the site is estimated from a topographic map to be approximately 300 to 500 acres (USGS 1981).

Because Liberty Bay and Puget Sound are salt water bodies, no domestic or irrigation surface water intakes are located within 15 miles downstream of the site. Approximately 36,699 salmon and 24,951 bottomfish were caught for sport in 1993 from within 15 miles downstream of the site (WDF&W 1993b). It is estimated that each salmon weighed 7 pounds and that each bottomfish weighed 3 pounds. Approximately 1,925,000 pounds of Chinook, 11,964,000 pounds of Chum, 13,461,000 pounds of Pink, 4,767,000 pounds of Coho, and 10,428,000 pounds of Sockeye salmon per year are caught commercially from Puget Sound (based on a five year average ending in 1993) (WDF&W 1993a). Further, approximately 6,207,000 pounds of other anadromous fish and salmon eggs were harvested commercially from Puget Sound annually for this period (WDF&W 1993a). It is estimated that 5% of fish and salmon eggs harvested commercially from Puget Sound are caught within 15 miles downstream of the site. Catch figures for species caught within 15 miles downstream of the site are provided in Table 6-6.

Table 6-6
FISH CATCH FIGURES WITHIN 15 MILES DOWNSTREAM OF SITE
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

Fishing Type	Type of Catch	Number of Fish	Fish Weight in Pounds	Total Pounds
Sport	Salmon	36,699	7	256,893
	Bottomfish	24,951	3	74,853
Commercial	Chinook			96,250
	Chum			598,200
	Pink			673,050
	Coho			238,350
	Sockeye			521,400
	Other Anadromous Fish and Salmon Eggs			310,350
Total				2,769,346

Sources: WDF&W 1993a; WDF&W 1993b

It is estimated from Wildlife Information Public Data Release maps that approximately 60 miles of wetlands exist within 15 miles downstream of the site (WDF&W 1996).

6.4 AIR MIGRATION PATHWAY

There is no one currently living or working at the site. A total of 12,991 people live within a 4-mile radius of the site (EPA 1996). The closest occupied home is located approximately 800 feet to the south. The Bald Eagle (*haliaeetus laucocophalus*), a Federally-and State-listed threatened species, is known to reside between 1/4 and 1/2 mile from the site (WDF&W 1996). Approximately 1,160.1 acres of wetlands are located within 4 miles of the site (EPA 1996). Table 6-7 provides populations and wetland acreage by distance ring within 4 miles of the site.

Table 6-7
POPULATIONS AND WETLAND ACREAGE WITHIN A 4-MILE RADIUS
FORMER NIKE MISSILE LAUNCH SITE #81
POULSBO, WASHINGTON

Distance (Miles)	Residents	Wetland Acreage
On a source	0	0
0 - 1/4	84	6.0
1/4 - 1/2	151	15.6
1/2 - 1	798	34.8
1 - 2	3950	312.9
2 - 3	4298	344.5
3 - 4	3710	446.4
Total	12,991	1,160.2

Source: EPA 1996; Petrovich 1996

7. SUMMARY AND CONCLUSIONS

The Former NIKE Missile Launch site #81 is an inactive U.S. Army NIKE Ajax missile launch facility located approximately 1 mile northwest of Poulsbo, Washington. Abandoned structures still at the site include three missile launch silos, a generator building, a missile assembly building, a acid fueling station, a maintenance shop, a water well house, and a barracks. Army activities at the site are believed to have initiated in 1956. The site property was sold in 1967 to (b) (6) (b) (6) who used the property for horse and cattle pasturage, and used the missile assembly building for a residence for a short period (1.5 years).

Past investigations and cleanup work at the NIKE site have been performed dating back to 1985 by private consultants as well as the USACE, which removed four USTs from the site and performed characterization and removal of affected soils near the tanks. Consultants for FWI performed a Phase I and II site assessment of the property in 1992 in which asbestos and soil samples were collected on site.

A total of 43 soil samples were collected at the NIKE site, only five of which contained elevated concentrations of cadmium, lead, magnesium, and nickel. All of these concentrations were at relatively low levels, with most just above detection limits and all below regulatory clean-up or risk-based action levels.

A total of ten groundwater samples were collected, seven of which were from off-site drinking water wells where no elevated concentrations were detected. Three samples were collected from on site, including shallow groundwater samples GW-1 and GW-2, which were collected from approximately 5 feet bgs near the transformer pad (by the generator building) and acid fueling station, respectively. Elevated concentrations of lead, magnesium, and nickel were identified and also exceeded MCL concentrations. However, these concentrations were detected in shallow groundwater samples using Geoprobe™ sampling equipment, and not from wells.

Sample DW-7, collected from the former on-site water well, contained elevated concentrations of lead and nickel. The concentration of lead exceeded MCL concentrations, however, DW-7 is no longer used for drinking water purposes and it is assumed it will not be in the future.

Elevated concentrations of 4,4-DDT were identified in GP-6 and GP-8 collected from around the maintenance shop area. These concentrations also exceeded Region III RBCs. No other elevated concentrations of organic compounds were identified in either source samples or target samples during laboratory analysis.

8. REFERENCES

Becker, Frederick, CHMM, Index Environmental Services, Inc., October 2, 1996, letter to Linda Foster, Ecology and Environment, Inc., regarding Water Analysis for Silos; Olhava Site, Poulsbo, Washington.

Bilodeau, Michael, Technical Manager, U.S. Army Corps of Engineers, October, 1996, telephone conversation with Linda Foster, Ecology and Environment, Inc., regarding the former Nike Launch Site #81, Underground storage tank closures.

Ecology and Environment, Inc., 1996, Sampling and Quality Assurance Plan (SQAP), NIKE Missile Launch Site #81, Poulsbo, Washington.

_____, 1996b, Preliminary Assessment Report, Former NIKE Missile Launch Site, Poulsbo, Washington.

_____, 1996c, site logbook, Site Inspection, Former NIKE Launch site #81, Poulsbo Washington.

ERM Northwest, Inc. (ERM), September 23, 1992, Phase I and Phase II Environmental Site Assessment, Nike Missile Base, Poulsbo, Washington.

Harza Northwest, Inc. (Harza), Preliminary Geotechnical Engineering Investigation, August 1994, for Olhava Development, L.P. Highway 3 and Finn Hill Road (former Nike site), Poulsbo, Washington.

Law Environmental Services (LES), No date provided, The Nike Missile Site Investigation Program.

McLeod, R., February 3, 1967, Preliminary Report, Request for Disposal Documents, Sale Parcel No. 1, Portion Army Nike-Ajax Site #81, Poulsbo, Washington, D-Wash-722.

Petrovich, Brad, Education/Outreach, Washington State Department of Ecology, (October 15, 1996), telephone conversation with Mike Martin, regarding Water Well Reports for the Nike site area.

Pittman, Mike, Bangor Naval Sub Base, Public Works Department, October 16, 1996, telephone conversation concerning public water supply well information at the base.

Reynolds, Jill, Facility Supervisor, General Electric Company, June 19, 1996, letter to (b) (6) (b) (6) Olhava Associates, L.P., regarding Final Disposal of PCB Materials.

Strickland, Chris, City of Poulsbo, Public Works Department, October 16, 1996, telephone conversation concerning public water supply well information for the City of Poulsbo, Washington.

U.S. Army Corps of Engineers (USACE), 1995, Terul Glen P.E. for Mike Bilodeau, Project Manager, U.S. Army Corps of Engineers, regarding petroleum contaminated soil sampling and determining extent of contamination at the former Nike Missile Launch Site #81, Poulsbo, Washington.

U.S. Army Engineer District (USAED), Defense Environmental Restoration Program, August 16, 1985, Seattle Defense Area Nike Battery #81 (Poulsbo), Kitsap County, Washington.

U.S. Department of Commerce (USDC), Bureau of Commerce, 1990, General Housing Characteristics, Washington State.

_____, 1973, National Oceanic and Atmospheric Administration (NOAA), Precipitation-Frequency Atlas of the Western United States, Volume IX - Washington.

U.S. Environmental Protection Agency (EPA), September 26, 1996, Site Information Query System, Former Nike site #81, Poulsbo, Washington.

_____, February, 1994a, Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

_____, February, 1994b, Contract Laboratory Program National Functional Guidelines for Organic Data Review.

_____, June, 1994, Using Qualified Data to Document an Observed Release, OSWER Publication 9285,7-14FS.

U.S. Geological Survey (USGS), 1981 revised, 7.5 Minute Series topographic maps of Lofall, Poulsbo, Port Gamble, and Suquamish, Washington, quadrangles.

Washington State Department of Ecology (DOE), 1997, Domestic water well logs for area surrounding NIKE Missile Launch site, Poulsbo, Washington.

Washington State Department of Fish and Wildlife (WDF&W), Habitat Program, February 1996, Priority Habitats and Species List, Habitat Program, January 1996, Olympia, Washington.

_____, 1993a, Fisheries Statistical Report.

_____, 1993b, Sport Catch Report for Foodfish.

White Shield, Inc. (WSI), March 1993, Closure Assessment Reports, Camp Hayden (ELWHA), Ollala Nike 62, Kingston Nike 92, Poulsbo Nike 81.

APPENDIX A

PHOTOGRAPHIC DOCUMENTATION

APPENDIX B

EM-31™ INVESTIGATION DATA FORMS

APPENDIX C

LABORATORY ANALYTICAL DATA FORMS